THE ORGANIZATION AND METHODS OF TEACHING THE SCIENCES RELATED TO VOCATIONAL AGRICULTURE

by

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INTRODUCTION

A Need for Some Knowledge of the Sciences Imperative. That it is necessary to teach a certain amount of the sciences along with vocational agriculture will, no doubt, be conceded by most of the vocational teachers. What sciences to teach, how much, and when to teach them then are questions with which the vocational teacher finds himself confronted. Most of the students who take vocational agriculture come to us in their freshman or sophomore years and therefore have not had an opportunity of taking any of the science courses that may be offered in their schools, as these science courses are usually taught in the third or fourth years. They know little or nothing about the sciences, and as a rule are not able to comprehend what is given relative to these sciences in our high school texts.

To properly understand certain phases of the work in agriculture it is imperative that the students who take these courses have some knowledge of the sciences. It is impossible to even read intelligently some of the contents of our high school texts without some knowledge of these science subjects. If we did not get these students until their junior or senior years, and they could have had an opportunity of taking the high school science courses, there

would be less need for giving instruction in the sciences. However, this is not usually the case. In the smaller high schools, and these are the schools that usually maintain courses in vocational agriculture, about the only related science subjects that are offered are those of general science, and possibly physics and biology in some cases, and these are not taught from the vocational agricultural viewpoint and do not fit in with the work in agriculture.

Organization of Material. If the above conditions prevail, and I believe that they do, it then devolves upon the teacher to organize his science material and get it across to his class in the best manner that he can, or "Pass it up" leaving the student with only a hazy notion of many phases of his work that might have been made clear to him had he received adequate instruction in these sciences.

It would be a happy state of affairs if our pupils could come to us with a working knowledge of these sciences. One, then, who has taught vocational agriculture for any length of time realizes that he must give his students instruction in certain related science subjects such as the chemistry of plant growth, animal nutrition, and soil formation, bacteria and their relation to these same subjects, insects and their control, and other related science subjects before he can successfully teach the agricultural subjects.

Texts Inadequate. Most of our texts, for use in high schools, seem to be written on the supposition that the students who use them will have had instruction in these subjects and are familiar with them, and therefore do not give the fundamentals, which the student must have before he can pursue these texts understandingly. There are, no doubt, some exceptions to the above, but I believe that in the main this is true. This related material may be found in the texts on the respective subject, but it must be collected, organized and put into as simple language as possible so that the student can understand it.

Objectives. This study, therefore, has been undertaken for the purpose of determining, if possible, what subjects are taught as related sciences in the vocational schools throughout the country, what phases of each science receive the most emphasis, how they are taught, when they are taught, by whom they are taught and on what basis they are taught.

Requirements by the Different States. It is evident from the material gathered that there are no definite requirements by the respective states as to teaching related sciences and that this is left largely to the discretion of the teachers, who are at liberty to handle the subject in any manner that to them seems fit. It is also evident that

in the vast majority of cases the sciences are taught by the vocational teacher, especially is this true in the smaller high schools and it is in these rural high schools that the majority of our vocational agricultural courses are maintained.

AN ACKNOWLEDGEMENT

The author wishes to take this opportunity of thanking the teachers who have taken enough interest in the subject to give his questionnaire thoughtful consideration. He also wishes to thank Dr. C. V. Williams, Professor of Vocational Education at the Kansas State Agricultural College, who has acted as his major instructor, for his kindly criticism and valuable counsel in the organization of the material.

AN ANALYSIS OF THE PROBLEM

Object of the Study. Ever since the introduction of vocational agriculture into the schools of this country teachers have recognized the fact, that in order to teach certain subjects as they should be taught it was necessary to incorporate a certain amount of the sciences along with the vocational subjects.

After ten years of teaching under the provisions of

the Smith-Hughes Act, teachers should have become fairly well settled in their minds relative to the correlation of the sciences and vocational agricultural subjects, but as yet, so far as my knowledge goes, no special effort has been made to collect data on the subject.

This study, therefore, has been undertaken for the purpose of determining, as near as possible, what science subjects should be considered as related sciences, what phases of the different science subjects should receive the greatest emphasis, when and where in the vocational courses these subjects should be taught, how much time should be devoted to teaching them, and what methods should be followed in presenting them to classes in vocational agriculture.

Evaluation. It is the hope of the author of this paper that the material herein contained, coming as it does from some of the best teachers of vocational agriculture in a number of the states, will be helpful to the teachers of Kansas, and any others who may chance to see it, in their efforts to stabilize their teaching of the sciences as they are related to the vocational agricultural subjects.

Arrangement. The subject will be discussed under the following heads:

Introduction

An Analysis of the Problem

How the Sciences Related to Vocational Agriculture are Taught in the Different States

Content and Method in the Biological Sciences

Content and Method in the Natural Sciences

General Conclusions

Methods of Procedure. In order to get the information necessary for such a study a letter was addressed to the State Supervisors of a number of states asking for the names and addresses of several of the best vocational teachers in the state, and also asking permission to send a questionnaire to these teachers. This request was granted and a list of names sent in from all of the Supervisors of whom the request was made with the exception of one. These lists of names varied in number from six to twenty and the questionnaire was sent to each of these teachers, as well as to all of the vocational teachers of Kansas. The information contained in these returned questionnaires, coming as it does from teachers chosen by their respective Supervisors as outstanding men in their profession, should carry considerable weight as related to the subject.

The states chosen were selected from widely separated localities in the United States with the hope of getting the viewpoint of teachers under as wide a range of conditions as possible. Sixty eight per cent of those to whom the questionnaire was sent responded, most of whom seem to have giv-

on the questionnaire painstaking thought, and from whom much valuable data have been secured. A considerable number took the pains to write personal letters, to more clearly state their positions, in addition to answering the questionnaire. A few, however, answered rather superficially, and from whom very little information was received.

That there would be considerable variation in the answers received, owing to the fact that the Smith-Hughes work is organized differently in the different states, was anticipated. An effort was made to so arrange the questionnaire that the answers might be as uniform as possible.

The following information was asked for:

I. How are the sciences related to vocational agriculture taught in your school?

1. As a part of the technical agriculture?

2. As a special short course?

3. As a prerequisite course to vocational agriculture?

4. Is there danger of teaching too much related science?

5. Should any more related science be taught than is absolutely necessary in order to give the vocational boy a comprehensive knowledge of his vocational subjects?

II. When should such related science be taught?

1. As the need for it arises in connection with the different enterprises?

2. Preparatory to the study of the different enterprises?

III. By whom should such related sciences be taught?

1. By the vocational teacher?

2. By the science teacher?

IV. On what basis is your science taught?

1. In connection with the jobs undertaken by the individual boy?

2. Pertaining to new technical agriculture about to be taught?

3. Is it essential that a certain amount of the sciences be taught in order that the vocational boy may better understand certain phases of vocational agriculture?

V. What related sciences do you teach?

VI. Chemistry.

1. How should chemistry be taught?

a. As a continuous course?

b. In connection with the study of soil formation and fertility, plant growth, animal nutrition, etc.?

2. How many 90 minute period (or the equivalent thereof) should be devoted to the teaching of chemistry?

a. The first year?

b. The second year?

VII. Bacteriology.

1. How many 90 minute periods (or the equivalent there of) should be devoted to the teaching of bacteriology?

2. What phases of the subject should receive the greatest emphasis?

a. As related to plant diseases?

b. As related to animal diseases?

c. As related to animal nutrition?

d. As related to the availability of plant food?

VIII. Botany.

1. How many 90 minute periods (or the equivalent thereof) should be devoted to the study of botany?

2. What phases of the subject should receive the greatest emphasis?

a. The functions of the different parts of the plant?

b. The structure of the plant?

c. The ecology of plant life?

d. The economic importance of plants?

e. The classification of plants?

f. Development of complexity of structure from lower to higher forms?

3. Should the botany taught be confined to the botany of farm crops?

IX. Zoology.

1. How many 90 minute periods (or the equivalent thereof) of the time devoted to animal husbandry should be given to zoology?

2. Where in the animal husbandry course should zoology be taught?

3. What phases of the subject should receive the greatest emphasis?

   a. Development from lower to higher forms?

   b. Functions of animal life?

   c. Classification of animal life?

X. Entomology.

1. How many 90 minute periods (or the equivalent thereof) should be devoted to entomology?

2. What phases of the subject should receive the greatest emphasis?

   a. Body structure?

   b. Life cycle?

   c. Means of combatting?

3. Should seasonal sequence be observed in teaching entomology?

XI. Genetics.

1. How many 90 minute periods (or the equivalent thereof) should be devoted to genetics in the study of plant and animal breeding?

XII. Geology.

1. Do our high school texts on soils give all of the geology that the vocational boy needs?

2. How many 90 minute periods (or the equivalent thereof) should be devoted to geology in a soils course?

XIII. Physics.

1. Does physics rightfully belong with the shop courses?

2. Should it be considered an essential part of such a course?

3. How many 90 minute periods (or the equivalent thereof) should be devoted to physics as related to such a course?

XIV. Plant Pathology.

1. Should any more plant pathology be taught than just enough to cover identification and means of control of the most important plant diseases?

2. How many 90 minute periods (or the equivalent thereof) should be given to plant pathology in a crops course?

3. Should seasonal sequence be observed in teaching plant pathology?

XV. Please estimate the approximate amount of time that you give to each of the related sciences out of the total amount of time given to teaching these sciences.

XVI. Methods.

1. Would it be a help to the teachers of vocational agriculture to have material on related sciences available in the form of a manual?

2. Does your state provide vocational teachers with such organized material for short courses in the related sciences?

3. Should such material be in the hands of the boy as supplementary to his regular texts?

4. If such supplementary material is not in the hands of the boy what is the best method for the teacher to use in getting this information across to the boy?

a. Should the teacher give it in the form of lectures?

b. Should it be placed on the board for the boy to copy?

c. Should it be procured from assignments in the various supplementary texts and bulletins on the different specific subjects?

Answers to the above questions were received from 166 teachers in 13 states including the following:

Alabama	Missouri
Connecticut	Minnesota
California	Massachusetts
Georgia	Nebraska
Iowa	Ohio
Kansas	Oregon

Pennsylvania

HOW THE SCIENCES RELATED TO VOCATIONAL AGRICULTURE ARE TAUGHT IN THE DIFFERENT STATES

Major Tendencies. A study of Table I, and the accompanying chart, reveals the following; namely, that the great majority of those reporting teach the sciences as a part of the technical agricultural courses and that in only a comparatively few schools are the sciences taught as special short courses. The data also bring out the fact that the most of the teachers do not attempt to teach the sciences until a need for the information arises in connection with the different enterprises. A few, however, prefer to teach the sciences preparatory to taking up the different enterprises arising in the agricultural courses.

In a few more than half of the schools from which reports were received the sciences are taught as they pertain

to and introduce new agricultural subjects about to be taken up for study by the class, while in a little less than half of the schools they are taught in connection with the job as undertaken by the class. There were a few others who stated that they did not teach the sciences in connection with the job, but who expressed themselves as believing that that would be a good way if time permitted.

The Sciences Prerequisite. It is also noticeable that in only a few schools are the sciences required as prerequisites to the vocational agricultural courses and in those schools where the sciences are required as prerequisites to the vocational agricultural courses, the agriculture is not offered until the third and fourth years of the high school course. A few expressed themselves as believing that the sciences should be taught as prerequisite courses when it is possible to arrange for such courses. There were still others who expressed themselves as believing that in the majority of cases such a procedure was not practical.

Who Teaches the Sciences. Table I also brings out the fact that in by far the greater number of schools the sciences are taught by the vocational teacher, while in a few schools they are taught by the science teacher. These latter schools are also those in which the vocational agriculture is taught during the last two years of the high school course, in which case there is an opportunity for the stu-

dents taking the agricultural courses to get, at least a part of their sciences, in the regular science courses.

"By whom the related sciences should be taught" brought forth more comment on the part of the various teachers reporting than any other one phase of how the sciences are taught. A number of the teachers seem to feel that the vocational teacher is already overburdened, and does not have time to teach the sciences, and for this reason they should be taught by the science teacher if the school maintains such a teacher. Others expressed themselves as doubting the advisability of the science teacher teaching the sciences to vocational students unless they are in direct sympathy with and understand the vocational students requirements and have the required knowledge of agriculture to correlate the subjects.

It seems to be the consensus of opinion that the vocational teacher knows best what should be taught and can do a more satisfactory job at it than the science teachers generally are able to do. The opinion seems to prevail that the vocational teachers should teach the sciences to vocational students unless the school plan permits of the sciences being taught before the students enter the vocational classes, and even then the agricultural teacher must review them and make applications. If taught by the science teacher the vocational teacher should at least outline the course.

When Taught. As to when the related sciences should be taught, there were a number of teachers who qualified their statements by saying that as much as possible the sciences should be taught as the need for them arises, but that it might not always be possible to do so, and that at least the knowledge should be applied as needed. Some were of the opinion that the sciences might be taught either as the need for them arises or preparatory to the study of the agricultural subject, stating that the instruction is more important than the time that it is given.

TABLE I. HOW THE SCIENCES RELATED TO VOCATIONAL AGRICULTURE ARE TAUGHT IN THE DIFFERENT STATES

States	Number Reporting from Each State	How Taught						When Taught				By Whom Taught		Basis on Which Sciences are Taught			
		As a Part of the Technical Agricultural Course		As a Special Short Course		As a Prerequisite Course		As Need for It Arises in Connection with the Different Enterprises		Preparatory to the Study of the Different Enterprises		By the Vocational Teacher	By the Science Teacher	In Connection with Job as Undertaken by the Class		Pertaining to and Introducing New Agricultural Subject About to be Taught	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No			Yes	No	Yes	No
Alabama	4	2	2	0	3	1	2	4	0	0	2	3	1	3	1	1	3
Connec.	5	2	3	1	4	1	4	3	2	3	2	3	2	2	3	2	3
Calif.	11	10	1	2	8	1	9	11	0	1	8	11	0	10	1	7	2
Georgia	7	5	2	1	5	3	4	6	1	3	3	5	3	4	3	5	2
Iowa	12	8	4	4	7	4	2	10	2	3	6	10	6	9	3	3	4

(Continued on next page)

Table I continued -

Kansas	69	64	5	8	55	6	55	62	4	14	46	66	8	31	31	47	18
Missouri	16	13	3	0	14	0	16	14	2	3	10	16	3	10	15	12	3
Minn.	8	5	3	2	6	1	5	7	1	1	4	6	5	6	2	3	5
Mass.	3	1	0	2	1	0	2	3	0	0	1	2	3	3	0	2	1
Nebraska	9	9	0	1	6	0	7	9	0	2	4	6	5	2	5	7	1
Ohio	8	2	6	1	7	4	3	5	5	3	0	3	6	3	4	6	1
Oregon	4	1	2	1	2	1	2	2	2	2	2	3	1	1	3	3	1
Pa.	10	7	3	2	7	1	7	7	2	4	4	9	3	4	6	7	3
Total	166	129	32	25	125	23	118	133	19	46	92	143	46	88	77	105	47

A careful examination of this table will show that in some instances the number answering certain questions does not balance with the number reporting from the respective states. This is accounted for from the fact that in some cases the teacher answering the questionnaire did not report on certain questions and in other cases others reported that they followed both plans.

Chart No. 1 shows that:

129 (or 80 per cent) teachers teach the related sciences as a part of the technical agricultural course.

32 (or 20 per cent) teachers do not teach the related sciences as a part of the technical agricultural course.

125 (or 83 per cent) teachers do not teach the related sciences in special short courses.

25 (or 17 per cent) teachers teach the related sciences as special short courses.

118 (or 83 per cent) teachers do not require the science courses as prerequisite to the vocational courses.

23 (or 17 per cent) teachers require the science courses as prerequisite to the vocational courses.

133 (or 87 per cent) teachers teach the sciences as the need for them arises in connection with the different enterprises.

19 (or 13 per cent) teachers do not teach the sciences as the need for them arises .

92 (or 67 per cent) teachers do not teach the sciences as preparatory to the study of the different enterprises.

46 (or 33 per cent) teachers teach the sciences preparatory to the study of the different enterprises.

In 143 (or 75 per cent) of the schools the sciences are taught by the vocational teacher.

In 46 (or 25 per cent) of the schools the related sciences are taught by the science teacher.

88 (or 53 per cent) of the teachers teach the sciences in connection with the job undertaken by the class.

77 (or 47 per cent) of the teachers do not teach the sciences in connection with the job undertaken by the class.

105 (or 69 per cent) of the teachers teach the sciences as they pertain to and introduce a new agricultural subject about to be taught.

47 (or 31 per cent) of the teachers do not teach the sciences as they pertain to and introduce a new agricultural subject about to be taught.

CONTENT AND METHOD IN THE BIOLOGICAL SCIENCES

Of the 166 teachers reporting on teaching the related biological sciences 127, or 77 per cent, teach botany, 107, or 64 per cent, teach bacteriology, 108, or 65 per cent, teach plant pathology, 121, or 73 per cent, teach entomology, 99, or 54 per cent, teach genetics, and 83, or 50 per cent, teach zoology.

It is evident from the above that teachers of vocational agriculture do not attach the same degree of importance to all of the biological sciences as they relate to vocational agriculture. Based on the number of teachers who teach these sciences in their vocational work, botany, entomology, plant pathology and bacteriology might be classed as those related biological sciences of major importance as related to the student's knowledge of his agricultural subjects, and genetics and zoology as those of minor importance.

Just why botany, as it relates to the production of farm crops, should be of greater value to the student than is zoology, as it relates to the production of farm animals, is not evidenced by the teachers who make the distinction.

It is apparent, from the data gathered, that the teachers making the report feel that it is imperative that these biological sciences be taught in connection with the vocational agricultural subjects, that they correlate so closely

that the agricultural student cannot acquire a comprehensive knowledge of his agriculture without, at least, the fundamentals of these sciences. On this point they all seem to agree. They differ, however, quite materially as to the different phases of these subjects that are of most importance in their relation to vocational agriculture, and also to a little less degree, as to the time that should be devoted to teaching them. Most teachers seem to feel, that while more than the fundamentals of these sciences would be a benefit to the student in the way of general information, the vocational teacher does not have time for more than just the fundamentals, or just what is absolutely essential for a comprehensive knowledge of the agricultural subject being pursued, and if he attempts to teach more than this he will crowd out some phases of the work in agriculture that is of more importance. Overloaded as he is with his multiplicity of duties the vocational teacher must confine his teaching of sciences to the minimum requirements.

The following tables and charts, with the accompanying content material, give the major tendencies of the 166 teachers from 13 states relative as to their practices in teaching the related biological sciences to students of vocational agriculture.

Botany

Content Tendencies. Table II and Chart No. 2 contain the classified information relative to teaching botany to vocational students. The information contained in this table and chart reveals the following:

(a) Teachers of vocational agriculture are practically unanimous in their belief that botany should be taught to vocational pupils as a part of their vocational agriculture.

(b) They vary greatly as to what phases of the subject is of greatest importance and to a less degree as to the time that should be allotted to teaching the subject.

(c) It is the belief of most of the teachers that the botany taught should be confined largely to the botany of farm crops, including orchard and garden plants. A few are of the opinion that it should include the botanical study of weeds, ornamental shrubs and flowers if time permits, but are of the opinion that time does not permit teaching more than will correlate closely with the production of farm crops. Some are of the opinion that it is a narrow view of the subject to confine it to farm crops and that the study of other plants should be included for illustrative material. These latter teachers express themselves as believing that more efficient teaching can be done by a departure from the botany of farm crops.

(d) All believe that the greatest emphasis should be placed on the botany of farm crops and that all teaching must be confined largely to fundamentals.

(e) The average number of 90 minute recitations devoted to teaching botany is eight and the average for the different states ranges from 0 to 10.

Order of Importance. Chart No. 2 shows the placings of the different phases of the subject, in the order of their importance, as indicated by the answers to the various questions, the placings being as follows for those phases of the subject receiving the first three highest rankings, and the number of teachers who would so place them.

Number of Teachers	First Place
81	Functions of the different parts of the plant
35	Economic importance of plants
28	Structure of the plant
6	Ecology of plant life
3	Classification of plants
1	Development of structure from lower to higher forms
	Second Place
61	Structure of the plant
49	Functions of the different parts of the plant
21	Economic importance of plants
8	Classification of plant life
5	Ecology of plant life

Second Place, Continued

Number of Teachers	
2	Development of structure from lower to higher forms

Third Place

44	Economic importance of plants
38	Structure of plants
15	Ecology of plant life
15	Classification of plants
14	Functions of the different parts of the plant
7	Development of structure from lower to higher forms

Methods of Presentation. The following on the methods of presenting the subject of botany to vocational students has been deduced from comments by the teachers reporting on the subject.

(a) A lesson should be given on the four great groups of plants and the type of plants that are found in each group.

(b) How plants increase in complexity of structure from the lower to the higher forms until we reach the spermatophytes, or the seed bearing plants, the group to which our farm plants belong.

(c) The plant structure, the functions of the different parts of the plant, their economic importance, something of their classification and how they reproduce are phases of the subject to be taught.

(d) The student should be taught how plants feed and grow, the different parts of the flower and the functions of each part. The above should be taught partially through laboratory exercises in which seeds are planted and their germination and growth observed.

(e) Different types of flowers should be examined for the identification of parts.

(f) How pollination and fertilization are brought about are important phases of the subject with which the student should be familiar.

(g) Scientific names and terms should be avoided when common names and terms will answer the purpose and minute details should be avoided when possible.

TABLE II. THIS TABLE SHOWS THE PHASE OF THE SUBJECT THAT IS GIVEN THE GREATEST EMPHASIS BY THE TEACHERS REPORTING, INDICATING 1ST, 2ND, 3RD, 4TH, 5TH, AND 6TH.

Botany

States	Number Reporting	Av. No. 90 Min. per. Used	Phases Receiving the Greatest Emphasis																	
			Functions of the Different Parts of the Plant						The Structure of the Plant						Ecology of Plant Life					
		Average	1st	2nd	3rd	4th	5th	6th	1st	2nd	3rd	4th	5th	6th	1st	2nd	3rd	4th	5th	6th
Ala.	4	4	1	2	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	1
Conn.	5	4	0	3	1	0	0	0	1	0	1	1	0	0	1	1	0	1	1	0
Cal.	11	3	5	4	1	0	0	0	3	6	0	1	0	0	0	0	2	1	4	3
Ga.	7	3	4	1	1	0	0	0	0	2	2	1	0	0	0	0	0	0	1	2
Iowa	12	14	4	4	1	1	0	0	3	0	4	2	2	0	2	0	0	2	3	1
Kans.	69	9	40	19	7	2	0	0	15	31	16	5	0	0	1	3	12	24	18	3
Mo.	16	10	8	4	2	0	0	0	0	8	5	1	0	0	0	1	0	5	2	3
Minn.	8	9	3	3	1	0	0	0	3	3	0	1	0	0	1	0	0	4	2	0
Mass.	3	0	3	0	0	0	0	0	0	2	1	0	0	0	0	0	0	1	0	0
Nebr.	9	9	7	1	0	0	0	0	0	6	0	1	0	0	1	0	1	1	2	1
Ohio	8	10	2	3	0	0	0	0	1	1	2	1	0	0	0	0	0	0	3	1
Oreg.	4	5	3	0	0	0	1	0	0	2	1	1	0	0	0	0	0	3	0	0
Pa.	10	9	1	5	0	0	1	0	2	0	5	1	0	0	0	0	0	3	2	1
Total	166		81	49	14	5	2	0	28	61	38	15	2	0	6	5	15	46	38	16

Range 0-14 90 minute periods
Median 7.23 90 minute periods

Table II, Continued -

States	Phases Receiving the Greatest Emphasis: Economic Importance 1st	2nd	3rd	4th	5th	6th	Classification 1st	2nd	3rd	4th	5th	6th	Development of Structure from Lower to Higher Forms 1st	2nd	3rd	4th	5th	6th
Alabama	2	0	0	0	0	1	0	1	1	0	0	0	0	0	0	1	2	0
Connecticut	2	0	1	1	0	0	0	0	0	1	2	0	0	0	0	0	0	3
California	2	0	6	1	2	0	0	0	0	4	2	2	0	0	1	2	3	2
Georgia	1	0	1	2	0	0	1	2	1	1	1	0	0	0	0	0	1	1
Iowa	3	5	0	1	0	0	0	1	3	0	3	1	0	0	1	1	0	5
Kansas	11	9	18	20	6	3	1	4	4	10	29	5	1	1	3	7	6	34
Missouri	5	1	5	2	1	0	1	0	0	4	5	1	0	0	0	1	3	7
Minnesota	2	1	3	1	0	0	0	0	1	1	3	2	0	1	0	2	0	4
Massachusetts	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Nebraska	0	1	4	3	0	0	0	0	2	1	3	1	0	0	1	0	1	5
Ohio	2	1	1	1	0	0	0	0	1	0	3	0	0	0	1	0	0	2
Oregon	1	0	3	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1
Pennsylvania	4	2	2	0	0	0	0	0	2	2	4	0	0	0	0	0	0	5
Total	35	21	44	32	9	4	3	8	15	25	56	12	1	2	7	14	17	70

Chart No. 2 shows the phases of the subject of botany given 1st, 2nd, 3rd, 4th, 5th and 6th place in importance, by the teachers reporting, and the number of teachers giving each placing:

Functions of the Different Parts of the Plant

81 (or 54 per cent) give this phase first place

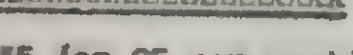
49 (or 33 per cent) give this phase second place

14 (or 10 per cent) give this phase third place

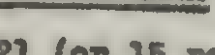
3 (or 2 per cent) give this phase fourth place

2 (or 1 per cent) give this phase fifth place

Economic Importance



35 (or 25 per cent) give this phase first place



21 (or 15 per cent) give this phase second place

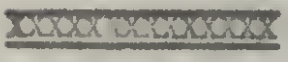
44 (or 32 per cent) give this phase third place

32 (or 23 per cent) give this phase fourth place

8 (or 6 per cent) give this phase fifth place

4 (or 3 per cent) give this phase sixth place

The Structure of the Plant



28 (or 20 per cent) give this phase first place

61 (or 44 per cent) give this phase second place

38 (or 27 per cent) give this phase third place

15 (or 10 per cent) give this phase fourth place

2 (or 1 per cent) give this phase fifth place

Ecology of Plant Life

6 (or 4 per cent) give this phase first place

5 (or 3 per cent) give this phase second place

15 (or 12 per cent) give this phase third place

46 (or 35 per cent) give this phase fourth place

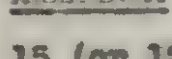
38 (or 30 per cent) give this phase fifth place

16 (or 12 per cent) give this phase sixth place

Classification of Plants

5 (or 2 per cent) give this phase first place

8 (or 7 per cent) give this phase Second place



15 (or 12 per cent) give this phase third place

XXXXXXXXXXXXX

25 (or 21 per cent) give this phase fourth place

XXXXXXXXXXXXXXXXXXXXXXXXXXXX

56 (or 47 per cent) give this phase fifth place

XXXXXX

12 (or 10 per cent) give this phase sixth place

Development of Structure from Lower to Higher Forms

X

1 (or 1 per cent) gives this phase first place

X

2 (or 2 per cent) give this phase second place

XXXX

7 (or 6 per cent) give this phase third place

XXXXXXX

14 (or 12 per cent) give this phase fourth place

XXXXXXXXX

17 (or 15 per cent) give this phase fifth place

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

70 (or 64 per cent) give this phase sixth place

Bacteriology

Content Tendencies. Table III and Chart No. 5 contain the compiled information relative to the teaching of bacteriology to students of vocational agriculture. The study brings out the following tendencies on the part of the vocational teachers.

(a) All teachers are of the opinion that bacteriology is one of the important sciences that should be taught in connection with the vocational agricultural subjects.

(b) The average number of 90 minute recitations devoted to teaching this subject is seven, and the variation in the average of the different states ranges from four to seventeen 90 minute recitations.

(c) As in botany, it will be seen that there is a considerable variation among the teachers as to the phases of the subject that are of greatest importance as related to vocational agriculture, however, they do not differ quite so widely as they do in the teaching of botany.

(d) In addition to the phases of the subject mentioned in the table a few teachers mentioned other phases of the subject which they considered important, such as the relation of bacteria to the production of dairy products, as related to the inoculation of legumes.

(e) As in botany, teachers are of the opinion that available time is the limiting factor in the amount of bacteriology that the vocational teacher is able to teach.

(f) A study of the comments, by the teachers reporting, leads one to believe that this wide variation among the different states as to the time that should be devoted to teaching bacteriology is due to the fact that the work is organized differently in the different states and that in those schools where so little as four recitations are devoted to the study of bacteriology are also the schools where the sciences are required as prerequisite subjects.

Order of Importance. Chart No. 3 shows the placings in the order of their importance as indicated by the answers to the various questions on this phase of the subject, the placings being as follows for those phases of the subject receiving the three highest rankings, and the number of teachers who would so place them:

Number of Teachers	First Place
47	As related to animal diseases
41	As related to plant diseases
35	As related to the availability of plant food
23	As related to animal nutrition

Number of Teachers

Second Place

48 As related to plant diseases

42 As related to the availability of plant food

40 As related to animal diseases

21 As related to animal nutrition

Third Place

42 As related to animal diseases

37 As related to animal nutrition

31 As related to plant diseases

29 As related to the availability of plant food

Methods of Presentation. From comments received relative to teaching bacteriology the following in regard to methods of presentation has been deduced:

(a) A definition of the term should be given, that they belong to the lowest order of plant life and that they are so small that they can be seen only with the aid of a microscope.

(b) Their importance in relation to animal nutrition, the availability of plant food, their relation to many of the plant and animal diseases, where they are found, how they grow and multiply, their different forms, their ability to form spores and withstand unfavorable conditions of cold, heat and moisture, their ability to again become active when conditions are again favorable, that some are harmful and others helpful and that others are harmless

should be taught.

(c) The vocational student should learn the important part that bacteria play in soil formation and in furnishing food to plants of higher order, their function in bringing about changes that occur in stable manure, what is meant by nitrogen fixing, nitrifying and denitrifying bacteria.

(d) The above should be taught partially through laboratory exercises in which the nodules found on the roots of legumes should be examined under the microscope. Some bacteria should be grown in some of the simpler cultures and also examined under the microscope. Some permanent mounts of a few of the more important kinds may be procured for study.

TABLE III. THIS TABLE SHOWS THE PHASES OF THE SUBJECT THAT IS GIVEN THE GREATEST EMPHASIS BY THE TEACHERS REPORTING, INDICATING 1ST, 2ND, 3RD, AND 4TH

Bacteriology

States	Number Reporting	No. 90 Min. Per. Used Av-erage	Phases Receiving the Greatest Emphasis: As Related to Plant Diseases 1st	2nd	3rd	4th	As Related to Animal Diseases 1st	2nd	3rd	4th	As Related to Animal Nutrition 1st	2nd	3rd	4th	As Related to Availability of Plant Food 1st	2nd	3rd	4th
Ala.	4	6	1	2	1	0	1	0	2	1	0	1	1	2	2	1	0	1
Conn.	5	5	1	3	1	1	1	1	2	1	0	1	4	1	2	1	0	3
Calif.	11	6	3	1	5	0	2	6	0	1	1	1	3	4	2	2	2	3
Ga.	7	17	2	1	1	0	0	0	2	2	1	0	0	2	1	3	0	0
Iowa	12	12	6	1	0	2	2	2	4	0	2	1	1	5	2	3	2	0
Kansas	69	5	17	19	13	14	20	23	18	7	13	10	15	24	14	19	17	14
Mo.	16	7	3	5	4	2	3	4	4	2	3	3	3	4	6	1	2	2
Minn.	8	6	1	4	2	0	7	0	0	0	0	1	2	4	0	3	1	2
Mass.	3	6	2	1	0	0	1	0	0	0	0	0	1	0	0	2	0	0
Nebr.	9	5	2	3	1	3	6	2	1	0	0	1	6	3	0	4	2	2
Ohio	8	10	2	2	1	2	1	0	4	1	1	2	0	5	2	1	3	0
Oreg.	4	4	1	1	1	0	0	2	1	0	1	0	1	1	1	0	0	2
Pa.	10	9	1	5	1	0	5	0	4	0	1	0	0	5	5	2	0	1
Total	166		41	48	31	24	47	40	42	15	25	21	37	58	38	42	29	30
Range		4-17	90 minute periods															
Median		7.53	90 minute periods															

Chart No. 3 shows the phases of the subject of bacteriology given 1st, 2nd, 3rd, and 4th place in importance by the teachers reporting and the number of teachers giving each placing:

As Related to Plant Diseases

41 (or 30 per cent) give this phase first place

48 (or 34 per cent) give this phase second place

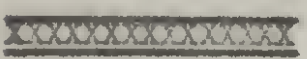
31 (or 22 per cent) give this phase third place

24 (or 17 per cent) give this phase fourth place

As Related to the Availability of Plant Food

35 (or 25 per cent) give this phase first place

42 (or 30 per cent) give this phase second place



29 (or 21 per cent) give this phase third place

[redacted]

30 (or 22 per cent) give this phase fourth place

As Related to Animal Diseases

[redacted]

47 (or 34 per cent) give this phase first place

[redacted]

40 (or 29 per cent) give this phase second place

[redacted]

42 (or 30 per cent) give this phase third place

[redacted]

15 (or 11 per cent) give this phase fourth place

As Related to Animal Nutrition

[redacted]

23 (or 16 per cent) give this phase first place

[redacted]

21 (or 15 per cent) give this phase second place

[redacted]

37 (or 26 per cent) give this phase third place

[redacted]

58 (or 42 per cent) give this phase fourth place

Plant Pathology

Content Tendencies. As to the teaching of plant pathology Table IV and Chart No. 4 reveal the following:

(a) That the great majority of the teachers devote some time to teaching plant pathology.

(b) That the average time devoted to this subject is seven 90 minute recitations and that the average for the individual states ranges from two to ten.

(c) That the states devoting the small amount of time are those in which the sciences are taught in the regular science classes as prerequisite courses, or in which the vocational agriculture is not taught in the freshman or sophomore years.

(d) The majority of the teachers do not teach more than is necessary in order to recognize the more important plant diseases and the application of methods of control.

(e) That in the main the teachers believe that seasonal sequence should be observed as far as possible, but that it is not essential when it is inconvenient to do so.

Methods of Presentation. There were no special comments on teaching plant pathology other than those brought out in Chart No. 4.

TABLE IV

Plant Pathology

States	No. Reporting From Each State	No. of 90 Min. Per Used Average	Should More Be Taught Than Identification and Control Yes	Should More Be Taught Than Identification and Control No	Should Seasonal Sequence Be Observed Yes	Should Seasonal Sequence Be Observed No
Ala.	4	3	0	4	4	0
Conn.	5	2	1	4	4	0
Calif.	11	8	2	9	11	0
Ga.	7	9	0	5	5	0
Iowa	12	9	3	8	8	3
Kansas	69	7	18	51	59	7
Mo.	16	5	2	13	14	1
Minn.	8	10	1	7	6	2
Mass.	3	10	0	3	3	0
Nebraska	9	7	1	8	6	3
Ohio	8	9	0	6	7	1
Oregon	4	9	0	4	4	0
Pa.	10	8	3	7	10	0
Total	166		31	129	141	17

Range 2-10 90 minute periods

Median 7.30 90 minute periods

Chart No. 4 shows that:

129 (or 80 per cent) of the teachers believe that no more plant pathology should be taught than identification and control of plant diseases.

31 (or 20 per cent) of the teachers believe that more plant pathology should be taught than identification and control.

141 (or 88 per cent) of the teachers believe that seasonal sequence should be observed in teaching plant pathology.

17 (or 12 per cent) of the teachers do not believe that it is necessary to observe seasonal sequence in teaching plant pathology.

Entomology

Content Tendencies. The findings of the study as indicated by Table V and Chart No. 5 show the major tendencies of the teachers relative to teaching entomology.

(a) The average time of all teachers reporting, allotted to teaching entomology, is eight 90 minute recitations and the variation in the time allotted to this subject in the various states ranges from 0 to 15. The apparent reason for this is the basis on which the work is organized in the different states.

(b) That all but thirteen teachers believe that seasonal sequence should be observed in teaching entomology.

(c) That means of combatting injurious insects is the most important phase of the subject to be taught.

Seasonal Sequence. In answer to the question as to whether or not seasonal sequence should be observed in teaching entomology there is considerable variation of opinion. While 141 teachers answered this question in the affirmative many of them qualified their answers. Twenty-six teachers believe that seasonal sequence should be observed as much as possible. Others hold the same opinion, but feel that it is very difficult to do so. Other answers received are "Where possible, but not necessary", "To a cer-

tain extent, it fits in nicely during the winter months", "Yes, should be taught in connection with each crop", "Yes, if practical", "Of course everything cannot be taught in season", "Yes, because of opportunity for field trips", "By all means", "Basic lessons may disregard seasonal sequence, but specific work must be seasonal".

Order of Importance. Chart No. 5 shows the placings in the order of their importance, of the different phases of the subject of entomology, as indicated by the teachers in their answers to questions as to the relative importance of the different phases of the subject, and the number of teachers so placing them.

Number of Teachers	First Place
93	Means of combatting
52	Life cycle
4	Body structure
	Second Place
86	Life cycle
43	Means of combatting
17	Body structure
	Third Place
112	Body structure
17	Life cycle
8	Means of combatting

Methods of Presentation. From comments received in answer to questions relative to teaching entomology the following conclusions relative to methods have been reached:

(a) Means of insect control is the phase of entomology that is of most vital importance to the student of vocational agriculture and should be emphasized in teaching.

(b) In order that control measures may be practiced it is important that the student be taught something of the life history and habits of those insects that are injurious to farm crops and animals.

(c) The student should be taught the meaning of the term "Metamorphosis" and the difference between complete and incomplete metamorphosis, how insects breathe, feed and reproduce.

(d) The student should learn what insects are harmful and what ones are beneficial and in what ways they are harmful and beneficial.

Genetics

Content Tendencies. The only data asked for in the questionnaire relative to genetics were as to the amount of time devoted to it. However, comments on the subject have brought some additional information.

(a) The average number of 90 minute recitation periods

devoted to teaching genetics is eight, and the variation of the average of the different states ranges from five to eleven 90 minute recitations.

(b) A number of teachers believe that the subject is too difficult for the average high school student.

(c) All the genetics that is necessary should be taught in connection with animal husbandry.

(d) Only enough should be taught to give a general understanding of the subject.

(e) Every farmer should have some knowledge of the laws and principles that govern breeding operations.

Methods of Presentation.

(a) The laws and principles that govern breeding operations are the same whether applied to the breeding of plants or the breeding of animals, and for this reason something of genetics should be taught along with the other sciences.

(b) A definite and concise statement of Mendel's law should be taught.

(c) What the meaning of such terms as "Prepotent", "Dominant", and "Recessive" characters are, etc.

TABLE V. THIS TABLE SHOWS THE AVERAGE NUMBER OF 90 MINUTE PERIODS DEVOTED TO TEACHING THE SUBJECT, BY THE TEACHERS REPORTING, AND THE PHASES OF THE SUBJECT RECEIVING THE GREATEST EMPHASIS, INDICATING 1ST, 2ND, AND 3RD

Entomology

States	Number Reporting	Number 90 Min. Per. Used Average	Body Structure 1st	Body Structure 2nd	Body Structure 3rd	Life Cycle 1st	Life Cycle 2nd	Life Cycle 3rd	Means of Combatting 1st	Means of Combatting 2nd	Means of Combatting 3rd	Should Seasonal Sequence Be Observed Yes	Should Seasonal Sequence Be Observed No
Alabama	4	5	0	2	2	0	2	2	4	0	0	4	0
Conn.	5	6	0	0	5	1	4	0	2	3	0	4	2
Calif.	11	8	1	4	5	0	8	3	9	0	1	10	1
Georgia	7	13	0	1	3	2	3	1	3	2	1	6	0
Iowa	12	10	0	2	5	3	6	0	5	2	1	10	0
Kansas	69	8	0	5	54	24	40	7	42	17	3	61	5
Mo.	16	7	1	1	13	7	8	0	7	6	2	14	1
Minn.	8	9	0	1	6	4	4	0	7	1	0	6	2
Mass.	3	0	0	0	1	1	0	2	2	1	0	3	0
Nebr.	9	7	0	0	7	3	5	0	6	2	0	7	2
Ohio	8	15	0	1	5	4	2	0	2	4	0	7	0
Oregon	4	7	1	0	3	2	2	0	1	3	0	4	0
Pa.	10	11	1	0	3	1	2	2	3	2	0	5	0
Total	166		4	17	112	52	86	17	95	43	8	141	15

Range 0-15 90 minute periods
Median 8.15 90 minute periods

Chart No. 5 shows the phases of entomology given 1st, 2nd and 3rd place in importance by the teachers reporting and the number of teachers giving each placing.

Means of Combatting

93 (or 64 per cent) give this phase first place

43 (or 30 per cent) give this phase second place

8 (or 6 per cent) give this phase third place

Life Cycle

52 (or 30 per cent) give this phase first place

86 (or 30 per cent) give this phase second place

17 (or 10 per cent) give this phase third place

Body Structure

4 (or 3 per cent) give this phase first place

17 (or 13 per cent) give this phase second place

112 (or 84 per cent) give this phase third place

Should Seasonal Sequence be Observed

141 (or 93 per cent) believe that seasonal sequence should be observed.

13 (or 7 per cent) do not believe that it is necessary to observe seasonal sequence.

Zoology

Content Tendencies. Table VI and Chart No. 6 show the following tendencies relative to teaching zoology to vocational students:

(a) That the average number of 90 minute recitations devoted to the study of zoology is seven, the same as that devoted to the study of plant pathology and bacteriology. It also shows that the lowest average number of 90 minute recitations devoted to the study of zoology by any one state is four, and that the highest average number of 90 minute periods devoted to the study of zoology by any one state is ten.

(b) The functions of animal life is by far the most important phase of the subject to be studied.

(c) "Where in the Animal Husbandry course zoology should be taught" brought forth a variety of answers. Thirty-five teachers are of the opinion that it should be taught before taking up the study of animal husbandry; seventeen believe that it should be taught in connection with animal breeding; sixteen advocated teaching it as the need arises; five feel that it should be taught in connection with genetics; and three are of the opinion that it should be taught at the end of the course. Other answers to the question

were "With the study of anatomy and physiology of animal life", "With each class of animals studied", "With animal nutrition", "With the development of the young", "In connection with diseases", "With each job", "In connection with the origin of animal life", "At odd times", "In relation to the subject studied", "During the winter months", "During the first semester", "During the second semester", "With the development of the breed", "With the origin of the breed", "When the first student asks a question about animal life".

(4) One teacher believes that zoology is not needed in a high school course.

Order of Importance. Chart No. 6 shows the placings in the order of their importance, of the different phases of the subject of zoology, as shown by the teachers in their answers to the question as to the relative importance of the different phases of the subject, and also the number of teachers making the placings.

Number of Teachers	First Place
85	Functions of animal life
12	Development from lower to higher forms
10	Classification of animal life
	Second Place
50	Classification of animal life

48 Development from lower to higher forms

44 Functions of animal life

Third Place

58 Classification of ani al life

54 Development from lower to higher forms

5 Functions of animal life

Methods of Presentation. From comments received from the teachers answering the questions relative to zoology the following conclusions have been reached relative to the methods of presenting the subject:

(a) Zoology bears the same relation to the production of animals that botany does to the production of plants.

(b) A study of the subject should be handled in about the same way.

(c) Only a minimum amount of time should be given to the study of the lower forms of life, teaching something of motion, nutrition, sensation, respiration and reproduction as they develop from lower to higher forms.

(d) Classification should be discussed briefly but not emphasized.

(e) Nutrition and reproduction, as it applies to the higher forms of animal life, will usually be discussed sufficiently in our texts on animal husbandry.

TABLE VI. THIS TABLE SHOWS THE AVERAGE NUMBER OF 90 MINUTE PERIODS DEVOTED TO TEACHING THE SUBJECT AND THE PHASES OF THE SUBJECT RECEIVING THE GREATEST EMPHASIS BY THE TEACHERS REPORTING, INDICATING 1ST, 2ND, AND 3RD

Zoology

States	Number Reporting	Number 90 Minute Periods Used Average	Development From Lower to Higher Forms 1st	2nd	3rd	Functions of Animal Life 1st	2nd	3rd	Classification of Animal Life 1st	2nd	3rd
Alabama	4	4	1	1	1	2	1	0	0	1	2
Connecticut	5	5	0	2	1	3	1	0	0	1	3
California	11	7	1	3	4	1	9	0	1	4	4
Georgia	7	4	0	0	2	0	2	0	1	1	0
Iowa	12	7	0	2	4	3	5	0	0	5	2
Kansas	69	6	9	20	24	34	22	3	4	21	27
Missouri	16	7	0	8	4	14	1	0	1	6	6
Minnesota	8	7	0	3	2	6	1	1	2	2	3
Mass.	3	5	0	0	1	3	0	1	0	0	1
Nebraska	9	5	0	4	2	6	0	0	0	2	4
Ohio	8	10	1	3	1	4	1	0	0	1	4
Oregon	4	7	0	0	3	3	1	0	1	2	0
Pa.	10	7	0	2	5	6	0	0	0	4	2
Total	166		12	48	54	85	44	5	10	50	58

Range 4-10 90 minute periods
Median 6.23 90 minute periods

Chart No. 6 shows the phases of zoology given 1st, 2nd and 3rd place in importance by the teachers reporting and the number of teachers giving each placing.

Functions of Animal Life

85 (or 63 per cent) give this phase first place

44 (or 33 per cent) give this phase second place

5 (or 4 per cent) give this phase third place

Development from Lower to Higher Forms

12 (or 10 per cent) give this phase first place

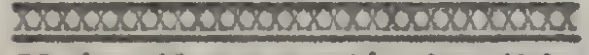
48 (or 42 per cent) give this phase second place

54 (or 48 per cent) give this phase third place

Classification of Animal Life

10 (or 9 per cent) give this phase first place

50 (or 42 per cent) give this phase second place



58 (or 49 per cent) give this phase third place

Summary Conclusions

From the foregoing material the following conclusions have been reached;

(a) Teachers of vocational agriculture do not attach the same degree of importance to all of the related biological sciences. They differ also considerably as to the phases of the different sciences that are of the most importance. However, in the majority of cases, a large number of teachers stress the same subject, and the same phases of these subjects, as being of major importance.

(b) Based on the reports received botany, entomology, plant pathology and bacteriology may be classed as the related biological science of major importance and those of genetics and zoology as those of minor importance.

(c) It is imperative that certain phases of the different biological sciences be made a part of the subject matter of vocational agriculture.

(d) The teacher of vocational agriculture does not have time to teach more than the fundamentals of these sciences without crowding out agricultural subject matter that is of more importance.

(e) The only phases of these subjects that should be taught are those that correlate closely with the vocational

agricultural subjects.

(f) There is a lack of uniformity among the teachers as to the organisation of the science material to be taught.

(g) Teachers disagree to quite an extent in their opinions as to the time that should be devoted to teaching the respective science subjects.

(h) In teaching those sciences where seasonal sequence becomes a factor in presenting the subject, it should be followed as near as circumstances will permit.

(i) Genetics correlates so closely with animal husbandry that it should be considered a part of that subject without discussing it as a separate science.

(j) Zoology is considered as being of less importance than any other of the biological sciences. This is probably due to the fact that it is incorporated in the work of animal husbandry rather than being taught as a separate related science.

CONTENT AND METHODS IN NATURAL SCIENCES

Of the 166 teachers reporting on teaching the natural sciences related to vocational agriculture 77, or 46 per cent, teach physics, 100, or 60 per cent, teach geology, and 123, or 74 per cent, teach chemistry.

Relative to teaching the natural sciences that relate to vocational agriculture we find that practically three-

fourths of the teachers reporting teach chemistry in connection with their agricultural subjects. This exceeds by 28 per cent those who teach physics and by 14 per cent those who teach geology. It is evident therefore that teachers feel that chemistry is more important as a natural science related to vocational agriculture than is either physics or geology. This is probably due to the fact that chemistry enters in, to a greater or less extent, to all vocational agricultural subjects while physics and geology do not.

Physics

Content Tendencies. Table VII and the accompanying chart contain data relative to the subjects of physics, geology and chemistry. The study brings out the following relative to teaching physics to vocational students:

(a) The average number of 90 minute recitations devoted to teaching physics is six and that the average for the individual states ranges from 0 to 9 90 minute recitations.

(b) Teachers are almost evenly divided in their opinion as to the phase of vocational work to which physics belongs. A little more than half of the number seem to feel that physics should be considered as a part of the shop course, as it is here that it may be applied, while a little less than half do not so believe.

(c) A few take the stand that physics should precede the shop course.

(d) All who believe that physics should be considered a part of the shop course agree that it is unwise to teach more physics than is essential for the best teaching of a shop course and that it should correlate closely with the course.

Methods of Presentation. Not a great deal of information on the methods of teaching was received, but what was received indicates the following:

(a) A brief discussion of the properties of matter.

(b) The emphasis should be placed on the principles of mechanics including levers, inclined plane, pulleys, wheel and axle and wedge and screw.

(c) The principles of the pump should be taught.

Geology

Content Tendencies.

(a) Teachers feel that it is not necessary to give as much time to teaching geology as to the other related sciences, five 90 minute recitation periods being the average time devoted to teaching this subject and the range for the different states being from 2 to 9.

(b) Practically two-thirds of the teachers believe that our school texts on soils give all the geology that the stu-

dent will have need for and that the teacher will have time to teach.

Methods of Presentation. As in physics very little data were received relative to methods of teaching geology, owing largely, it would seem, to the fact that teachers largely depend on their texts on soils for their content and methods.

(a) A brief discussion of the different geological periods.

(b) A brief study of the different classes of rocks.

Chemistry

Content Tendencies. The following is deduced from the answers to the questionnaire relative to teaching chemistry:

(a) The average number of 90 minute recitations devoted to teaching chemistry for the first year of the vocational agricultural course is eight and for the second year nine. The average number of 90 minute recitations for the individual states ranges from none at all to fifteen for the first year and from none to twelve for the second year.

(b) Teachers, as a rule, do not believe that chemistry should be taught as a continuous short course.

(c) All but ten of the teachers reporting believe that chemistry should be taught in connection with the study of soil formation, plant growth, animal nutrition, etc.

(d) A few prefer a short continuous course to get fun-

damentals and then fit into specific places.

(c) Others prefer that a Vocational Chemistry Course be offered in the school.

Methods of Presentation. It is evidenced from the reports received that the following methods of presenting the subject of chemistry to classes in vocational agriculture are those used by the teachers reporting.

(a) The first few lessons in chemistry should consist of a continuous short course in which fundamentals only are taught.

(b) This short course should be given during the first year that the student takes vocational agriculture.

(c) After these fundamentals have been taught any additional teaching should come at the time that the need for it arises in connection with the various vocational subjects that the student is pursuing.

(d) The subjects in which a knowledge of chemistry is needed are those relating to soil and soil fertility, plant growth, and animal nutrition.

(e) Fundamentals may be considered to consist of the following: A definition of the term, the names and the symbols for the fifteen or more elements a knowledge of which is necessary in connection with the study of agriculture, a

knowledge of the properties of these elements, what molecules and atoms are, what elements, mixtures and compounds are, what is meant by a chemical equation and how to read the simpler ones, what a formulae is, what acids, bases and salts are and how they react on each other and the results of these reactions.

(f) The above to be taught through laboratory exercises where such exercises will apply.

(g) Chemistry should be taught by the vocational teacher, unless it is required as a prerequisite course, and then the vocational teacher must review the subject and apply it as the needs of his agricultural subjects demand.

(h) Do not teach more than is absolutely essential to the present needs of the student.

TABLE VII. THIS TABLE SHOWS THE AVERAGE NUMBER OF 90 MINUTE PERIODS DEVOTED TO TEACHING PHYSICS, CHEMISTRY AND GEOLOGY, BY THE TEACHERS REPORTING, WITH ADDITIONAL INFORMATION AS INDICATED IN THE TABLE

		Physics			Geology		
States	Number Reporting	Number 90 Minute Periods Used Average	Should Physics be Considered an Essential Part of the Shop Course Yes	No	Number 90 Minute Periods Used Average	Do High School Texts on Soils Give All the Geology Needed Yes	No
Alabama	4	5	2	2	6	0	4
Connecticut	5	6	3	1	8	4	1
California	11	9	11	0	5	7	4
Georgia	7	6	1	4	9	4	2
Iowa	12	7	4	8	5	8	3
Kansas	69	7	40	23	5	40	24
Missouri	16	4	3	12	6	12	2
Minnesota	8	3	2	6	5	6	2
Massachusetts	3	0	2	1	6	3	0
Nebraska	9	6	7	2	4	5	4
Ohio	8	0	2	4	6	4	4
Oregon	4	5	2	0	4	1	2
Pennsylvania	10	7	5	6	7	7	2
Total	166		84	69		101	54
		Range 0-9 90 minute periods			Range 2-9 90 minute periods		
		Median 5.0 90 minute periods			Median 5.5 90 minute periods		

TABLE VII, CONTINUED -

Chemistry

States	Number Reporting	Number 90 Minute Periods Used Average First Year	Number 90 Minute Periods Used Average Second Year	As a Continuous Short Course Yes	As a Continuous Short Course No	In connection with the Study of Soil Formation, Plant Growth, Animal Nutrition, etc. Yes	In connection with the Study of Soil Formation, Plant Growth, Animal Nutrition, etc. No
Alabama	4	3	0	0	3	4	0
Conn.	5	8	12	0	5	5	0
Calif.	11	14	9	1	8	9	1
Georgia	7	15	12	2	3	6	0
Iowa	12	11	9	3	4	9	2
Kansas	69	8	8	12	50	67	2
Missouri	16	8	9	2	13	15	0
Minnesota	8	10	6	2	3	6	1
Mass.	3	0	10	0	3	3	0
Nebraska	9	5	6	0	6	9	0
Ohio	8	5	5	6	1	6	1
Oregon	4	5	12	3	1	2	2
Pa.	10	10	10	3	6	9	1
Total	166			34	106	150	10

Range first year 0-15 90 minute periods
Median first year 7.85 90 minute periods

Range second year 0-12 90 minute periods
Median second year 8.30 90 minute periods

Chart No. 7 shows the average number of 90 minute periods devoted to teaching physics, chemistry and geology, physics as related to the shop course, chemistry as a short course or in connection with the study of soil formation, plant growth and animal nutrition, by the teachers reporting, together with their opinion as to whether or not our texts on soils contain all the geology needed.

Physics

As a Part of the Shop Course

84 (or 55 per cent) of the teachers are of the opinion that physics should be considered an essential part of the shop course.

69 (or 45 per cent) of the teachers do not believe that physics should be considered an essential part of the shop course.

Chemistry

As a Continuous Short Course

34 (or 24 per cent) believe that chemistry should be taught as a separate short course.

106 (or 76 per cent) of the teachers do not believe that chemistry should be taught as a separate short course.

In Connection with the Study of Other Phases of Agriculture

150 (or 93 per cent) of the teachers believe that chemistry should be taught in connection with the study of soil formation, plant growth, animal nutrition, etc.

10 (or 7 per cent) of the teachers do not believe that chemistry should be so taught.

Geology

101 (or 65 per cent) of the teachers believe that our texts on soils give all the geology that vocational students need.

54 (or 35 per cent) of the teachers are of the opinion that our texts on soils do not give all the geology that the vocational student needs.

Summary Conclusions

(a) Teachers attach more importance to chemistry than to any other of the natural sciences.

(b) The above is due to the fact that chemistry enters into a greater number of the vocational subjects, to a greater or less extent, than does either physics or geology.

(c) Teachers are divided in their opinion as to whether or not physics should be considered a part of the shop course.

(d) Our texts on soils give all the geology that the student will have a need for and that the teacher will have time to teach.

(e) These sciences should be taught by the vocational teacher unless they are required as prerequisite, and even then the vocational teacher must review them.

(f) No more of the natural sciences should be taught than correlate closely with vocational agricultural subjects.

GENERAL CONCLUSIONS

Interesting Data. The teachers were asked to make an approximate estimate of the amount of time given to teaching each of the sciences out of the total time devoted to teaching the related sciences. Table VIII gives this information.

The numbers above the line indicate the per cent of time devoted to each subject and those below the line the number of teachers who devote the given per cents of time to the various subjects.

TABLE VIII

Science	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
Chemistry	1	8	3	1	8	4	1	0	1	17
Bacteriology	6	8	5	0	23	8	1	2	2	24
Botany	2	3	6	2	10	0	1	5	1	21
Zoology	2	10	8	1	20	1	4	5	1	12
Entomology	0	5	9	4	8	3	2	8	0	25
Genetics	5	6	6	9	22	4	2	2	0	24
Geology	5	6	10	7	23	5	4	5	0	19
Physics	7	6	9	3	19	4	0	2	0	8
Plant Pathology	2	3	8	5	20	6	0	6	2	29

(Continued)

	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
Chemistry	0	0	0	3	17	0	0	1	0	20
Bacteriology	0	6	0	0	9	0	0	1	0	8
Botany	1	1	1	2	26	2	1	3	0	20
Zoology	3	4	0	0	5	0	0	2	0	5
Entomology	2	4	0	0	17	1	2	0	0	9
Genetics	1	5	0	0	6	2	0	0	0	4
Geology	2	2	0	0	6	0	0	2	0	1
Physics	0	0	1	0	4	0	0	0	0	5
Plant Pathology	1	3	2	0	9	0	0	1	0	4

A close observer of the above table will notice that in answer to the question "What part of the total time devoted to teaching the related sciences do you give to teaching each science" the great majority of the teachers have designated 5 per cent, or some multiple of 5 as the proportion of time devoted to the individual science subjects. Just why

so many of the teachers reporting designated 5, 10, 15 or 20 per cent as the proportion of time, out of the entire time devoted to teaching the related sciences, to the respective science subjects is not apparent in their answers to the question.

The only probable reason that presents itself to the author of this thesis is that it would be somewhat of a task to study out the close approximate time and these teachers have designated the above per cents as being fairly closely approximate and that the numbers 5, 10, 15 and 20 are those that most readily come to mind in an approximate estimate.

Lack of Agreement Among Teachers.

(a) Teachers do not attach the same degree of importance to all of the related science subjects.

(b) In the biological sciences botany, entomology, plant pathology and bacteriology are considered of more importance than genetics and zoology.

(c) In the natural sciences chemistry is considered of more importance than physics and geology.

(d) Teachers do not agree as to the amount of time that should be devoted to teaching the related sciences.

(e) Teachers do not agree as to when during the agricultural course these related sciences should be taught.

The Probable Reasons for This Disagreement.

(a) The vocational work is organized differently in the different states, some of the states requiring some of the science subjects as prerequisite to the vocational work.

(b) Teachers probably have a tendency to stress those science subjects in which they have the greatest interest. One may have a natural liking for the biological sciences and stress these. Chemistry may appeal to another and he will stress that subject.

(c) The locality in which the school is located may be a factor. Plant diseases may cause considerable trouble in one locality and the teacher in that locality will emphasize plant pathology. Insect enemies may bother in another and the teacher in that locality will give more attention to entomology.

(d) The variation in the time devoted to teaching the different related sciences is possibly due to the phase of vocational agriculture that is being stressed. If the school is situated in a stock country the teacher in that locality may give more time to those sciences that relate to animal husbandry. If in a community where the farming is largely grain farming it will be natural to stress those related sciences that correlate with the study of crops.

Conclusions. This study indicates the following five conclusions relative to teaching related sciences to classes in vocational agriculture:

I. A Knowledge of the Sciences Necessary.

(a) A knowledge of the related sciences is vital to a good understanding of the different vocational agricultural subjects.

(b) Teaching the sciences is one of the important problems of the vocational teacher.

(c) A knowledge of the sciences is the backbone of an understanding of agriculture.

(d) Most high school students have acquired very little information in these sciences.

II. Basic Principles and Fundamentals Only Should be Taught.

(a) The basic principles and fundamentals, simply and plainly put, is all that should be taught.

(b) It is hardly possible to make the material too elementary.

(c) It should be practical.

(d) The more definite the information we put before our pupils to study the greater will be their achievement.

III. Should be Taught by the Vocational Teacher.

(a) The vocational teacher is better prepared to teach the related sciences in their agricultural application than

is the regular science teacher.

(b) Too much irrelevant material is taught unless the sciences are either taught or outlined by the vocational teacher.

(c) Farm boys will get a more practical knowledge of the related science subjects if they are taught by the vocational teacher.

(d) The vocational teacher's view point is better than that of the science teacher.

(e) As taught by the science teacher the related sciences do not carry over to the work in agriculture as they should.

IV. Should be Taught in Connection with the Vocational Subjects.

(a) With the exception of a continuous short course of a few lessons to get the fundamentals all science should be taught in connection with the vocational agricultural subject as the need for it arises.

(b) All science material should correlate closely with the agricultural subject.

(c) To use more time for teaching sciences than the above will necessitate eliminating some phases of the agricultural subjects that will be worth more to the vocational student than the extra science material.

V. Methods Most Commonly Agreed Upon.

(a) That the related sciences should be taught by the vocational teacher.

(b) That time does not permit teaching more than is necessary for an adequate understanding of the agricultural subject.

(c) The lessons in science should be taught in connection with the agricultural subject.

(d) Where seasonal sequence is a factor in teaching a science it should be followed as near as possible, but it is not always possible to do so.

BIBLIOGRAPHY PROBLEM

The careful reader of this thesis will, no doubt, ask the question "Where is the bibliography?" A careful search by the author failed to find anything on the subject aside from what Dr. C. V. Williams, Professor of Vocational Education, Kansas State Agricultural College, Manhattan, has written relative to sciences related to vocational agricultural agriculture in his "Fundamentals Involved in the Organization and Conduct of Vocational Agricultural Schools and Classes". In this treatise Dr. Williams has discussed the attitude of the different states relative to requiring courses in physics, chemistry and biological sciences of vo-

cational agricultural students. Aside from the above the author has had to rely wholly on answers to his questionnaire for his material.

The probable reason for the lack of material on this subject is that vocational agriculture is a comparatively new subject in the field of education and many of its phases have not yet been fully worked out, and the subject of related sciences is one of them. Probably within the next few years vocational agricultural teachers, and teacher trainers, will have crystalized material on this subject that will be available for reference, to which the author of this paper hopes to have made some little contribution. However, at the present time there is no material available other than that mentioned above.